DOCUMENT RESUME

ED 048 467 VT 012 474

AUTHOR	Kahler, Alan A.
TITLE	An Experimental Evaluation of the Effectiveness of Selected Techniques and Resources on Instruction in Vocational Agriculture.
INSTITUTION	Iowa Agricultural and Home Economics Experiment Station, Ames.; Iowa State Univ. of Science and Technology, Ames.
SPONS AGENCY	Iowa State Dept. of Public Instruction, Des Moines. Div. of Vocational Education.
PUB DATE	70
NOTE	44p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	Control Groups, Conventional Instruction, Effective Teaching, Evaluation Techniques, Experimental Programs, *Experimental Teaching, *Instructional Aids, Research Methodology, Secondary School Students, Statistical Analysis, *Teaching Methods, *Teaching Techniques, *Vocational Agriculture, Vocational Agriculture Teachers

ABSTRACT

The study was designed to test new instructional techniques in vocational agriculture, determine their effectiveness on student achievement, and compare individual and group instructional techniques. Forty-eight randomly selected Iowa high school vocational agriculture programs with enrollments of 35 students or more, were selected for testing the instructional approaches, using seven pilot programs and one control group. The eight approaches included (1) audio-tutorial, (2) single concept film, (3) prepared lesson plan, (4) field trip, (5) demonstration, (6) video-tape, (7) overhead projected transparency, and (8) traditional. Instructional materials, covering four different units, were designed by the investigators specifically for this study. Posttests indicated that all eight approaches had been effective, thereby suggesting that these techniques be considered by vocational agriculture instructors. (GEB)

ED0 48467

AN EXPERIMENTAL EVALUATION OF THE EFFECTIVENESS OF SELECTED TECHNIQUES AND RESOURCES ON INSTRUCTION IN VOCATIONAL AGRICULTURE

VT012474

by

Alan A. Kahler

Conducted under research grants from the

Vocational Education Branch
(VEA – 1963 – 4(a) Ancillary Funds)
Iowa Department of Public Instruction

and

Iowa State University Agricultural and Home Economics
Experiment Station
Ames, Iowa

Iowa State University
of Science and Technology
Ames, Iowa

1970

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

INVESTIGATING TEAM

Professor C. E. Bundy	Project Co-director
Dr. Alan A. Kahler	Project Co-director
Dr. Thomas A. Hoerner	Consultant in Agricultural Mechanics
Dr. Roger Volker	Consultant in Educational Media
Dr. Trevor Howe	Consultant in Educational Statistics
Dr. Roy D. Hickman	Consultant in Statistics
Dr. Anton Netusil	Consultant in Educational Statistics
Mr. Norval McCaslin	Graduate Student in Agricultural Education
Mr. Sidney Borcher	Graduate Student in Agricultural Education
Mr. Gary McVey	Graduate Student in Agricultural Education
Mr. Joseph Bendixen	Graduate Student in Agricultural Education
Mr. Herbert Hanson	Graduate Student in Agricultural Education
Mr. John Klit	Graduate Student in Agricultural Education
Mr. Donald Ahrens	Graduate Student in Agricultural Education
Mr. Daniel Beane	Graduate Student in Agricultural Education
Mr. Lloyd Tindall	Graduate Student in Agricultural Education

ED 048467

TABLE OF CONTENTS

Page

PURPOSE OF THE STUDY 1

DELIMITATIONS OF THE STUDY 2

METHOD OF PROCEDURE 2
- Definition of terms 2
- Selection of sample 3
- Development of instructional techniques and subject matter 3
- Development and administration of pre- and post-tests 3
- Collection of student and instructor data 6
- Training of teachers 6
- Analysis of data 7

FINDINGS 8
- Part I – Animal Health 8
- Part II – Commercial Fertilizer 12
- Part III – Small Gasoline Engines 19
- Part IV – Farm Credit 25

CONCLUSIONS AND IMPLICATIONS 30

APPENDIX A 35

VT 012 474

LIST OF TABLES

		Page
Table 1.	Treatments schools, instructors, and number of students participating in the study	4
Table 2.	Dependent, organismic, and concomitant variable treatment means in animal health	9
Table 3.	Analysis of variance of pre-test scores by treatment group in animal health	11
Table 4.	Analysis of variance of post-test scores by treatment group in animal health	11
Table 5.	Two-factor experiment with repeated measures analysis of pre- and post-test mean scores in animal health	12
Table 6.	Stepwise regression analysis of organismic and concomitant variables (X) on the dependent variable post-test (Y) in animal health (F-value to enter or remove = 3.000)	13
Table 7.	Analysis of co-variance for post-test differences among groups in animal health controlling for crop acres on home farm, agricultural achievement score, pre-test score, and teacher knowledge of subject matter	13
Table 8.	Animal health treatment means adjusting for differences due to pre-test score, crop acres on home farm, agricultural achievement score, and teacher knowledge of subject matter	13
Table 9.	Dependent, organismic, and concomitant variable treatment means in commercial fertilizer	14
Table 10.	Analysis of variance of pre-test mean scores by treatment group in commerical fertilizer	16
Table 11.	Analysis of variance of pre-test mean scores by treatment group in commercial fertilizer	16
Table 12.	Two-factor experiment with repeated measures analysis of pre- and post-test mean scores in commercial fertilizer	17
Table 13.	Stepwise regression analysis of organismic and concomitant variables (X) on the dependent variable post-test (Y) in commercial fertilizer (F-value to enter or remove = 3.000)	18
Table 14.	Analysis of co-variance for post-test differences among treatments in commercial fertilizer controlling for Differential Aptitude Test–Abstract Reasoning, pre-test score, and crop acres on students' home farms	18
Table 15.	Commercial fertilizer treatment means adjusting for differences due to Differential Aptitude Test–Abstract Reasoning, pre-test score, and crop acres on students' home farms	19
Table 16.	Least significant differences between adjusted treatment means in commercial fertilizer	19
Table 17.	Dependent, organismic, and concomitant variable treatment means in small gasoline engines	20

Table 18. Analysis of variance of pre-test mean scores by treatment group in small gasoline engines 22

Table 19. Analysis of variance of post-test mean scores by treatment group in small gasoline engines 22

Table 20. Two-factor experiment with repeated measures analysis of pre- and post-test mean scores in small gasoline engines 23

Table 21. Stepwise regression analysis of organismic and concomitant variables (X) on the dependent variable post-test (Y) in small gasoline engines 23

Table 22. Analysis of co-variance for post-test differences among treatments in small gasoline engines controlling for teacher knowledge of subject matter, semesters of vocational agriculture, non-crop acres on home farm, Kuder-Social Service, agricultural achievement score, and intelligence quotient 24

Table 23. Small gasoline engines treatment means adjusting for differences due to teacher knowledge of subject matter, semesters of vocational agriculture, non-crop acres on home farm, Kuder-Social Service, agricultural achievement score, and intelligence quotient 24

Table 24. Dependent, organismic, and concomitant variable treatment means in farm credit 26

Table 25. Analysis of variance of pre-test mean scores by treatment group in farm credit 28

Table 26. Analysis of variance of post-test mean scores by treatment group in farm credit 28

Table 27. Two-factor experiment with repeated measures analysis of pre- and post-test mean scores in farm credit 28

Table 28. Stepwise regression analysis of organismic and concomitant variable (X) on the dependent variable post-test (Y) in farm credit (F-value to enter or remove = 3.000) 29

Table 29. Analysis of co-variance for post-test differences among treatments in farm credit controlling for intelligence quotient, Kuder-Clerical, teacher tenure in teaching vocational agriculture, and pre-test score 29

Table 30. Farm credit treatment means adjusting for differences due to intelligence quotient, Kuder-Clerical, teacher tenure in teaching vocational agriuclture, and pre-test scores 29

AN EXPERMENTAL EVALUATION OF THE EFFECTIVENESS OF SELECTED TECHNIQUES AND RESOURCES ON INSTRUCTION IN VOCATIONAL AGRICULTURE

by

Alan A. Kahler

PURPOSE OF THE STUDY

One of the most pressing problems confronting agricultural educators is that of making instruction in vocational agriculture at the secondary school level more relevant and realistic to the student. With current changes in secondary school scheduling patterns, the importance of this problem becomes even more acute. In recent years, several new instructional techniques and resources have appeared on the educational scene that offer promise of achieving more student involvement in the learning process. These techniques, however, have been used largely in other disciplines within the high school curriculum. Information is needed that will evaluate their effectiveness and use in secondary school programs of vocational agriculture.

The central problem of this study was to evaluate the effects of selected treatment and classification factors and their interactions on instruction in the vocational agriculture program. The central problem was elaborated into the following parts:

1. To compare seven "pilot" programs of teaching vocational agriculture with a "control" group, with all eight groups incorporated into an experimental design.
2. To examine the relative effectiveness of eight instructional approaches in teaching vocational agriculture. These approaches were identified as:
   a. Audio-tutorial
   b. Single concept film
   c. Prepared lesson plan
   d. Field trip
   e. Demonstration
   f. Video-tape
   g. Overhead projected transparency
   h. Traditional
3. To investigate the effects of classification factors pertaining to high school students on the dependent variables, and to study the interactions of classification factors by treatment factors.

The principal objectives of the study were:

1. To test new instructional techniques and resources in the teaching of vocational agriculture in Iowa.
2. To determine the effectiveness of these techniques and resources on student achievement at each of the four high school grade levels in subject matter studied at each grade level.
3. To compare the effectiveness of individual and group instructional techniques and resources on student achievement in vocational agriculture.

The study was supported with funds provided through the Research Coordinating Unit, Vocational Education Branch, Iowa Department of Public Instruction, and the Iowa State University Agriculture and Home Economics Experiment Station. The study was conducted under the supervision of staff members in the Department of Agricultural Education assisted by graduate students in agricultural education.

DELIMITATIONS OF THE STUDY

The study was limited to an investigation of eight instructional approaches in 48 randomly selected Iowa high school vocational agriculture programs that were approved four-year programs with enrollments of 35 students or more. Each of the schools selected to participate in the study were conducting four regular day classes at each of four grade levels: ninth grade, tenth grade, eleventh grade, and twelfth grade. Excluded from the study were schools in which teachers were experiencing their first year of teaching.

The experiment covered a time period of 15 consecutive instructional days and instructional materials designed by the investigators specifically for use in the study. The instructional materials used by all schools dealt with animal health in the ninth grade, commercial fertilizers in the tenth grade, small gasoline engines in the eleventh grade, and farm credit in the twelfth grade. Outlines of the materials covered at each grade level are provided in Appendix A.

METHOD OF PROCEDURE

Definition of Terms

In order to clarify the meanings of various terms used in this experiment, the following definitions were made:

1. *Treatment factor.* A treatment factor is a condition of the experiment controlled by the investigators. The "pilot" programs, therefore, were instructional factors.

2. *Classification factor.* A classification factor is a natural stratification or dichotomization of schools or pupils on a variable of interest, which is not subject to control by the investigators except that the levels of ranked quantitative factors may be determined by the investigators.

3. *Experimantal unit.* The design of the experiment called for the treatment to be applied to schools, as intact units. Hence, the school was the prime experimental unit.

4. *Schools.* Schools referred to the high school attendance unit, to the department of vocational agriculture within the school, and/or to the school community.

5. *Instructional approach.* An instructional approach was one that provided a specific approach to providing instruction in a given situation. In this investigation, they were referred to as (1) audio-tutorial, (2) single concept film, (3) prepared lesson plan, (4) field trip, (5) demonstration, (6) video-tape, (7) overhead projected transparency, (8) traditional.

6. *Pilot program.* A pilot program is a planned activity for testing a new idea in a realistic field situation.

7. *Organismic variable.* Classification of students based on physical, physiological, and psychological characteristics.

8. *Concomitant variable.* Classification of students based on factors associated with the students involved in the investigation.

Selection of Sample

High schools in Iowa offering an approved four-year program of vocational agriculture with an enrollment of 35 students or more were identified and listed for sampling. Using the table of random numbers, 48 high schools were randomly selected for inclusion in the study and each randomly assigned to one of the eight treatment groups. School administrators, vocational agriculture instructors, and guidance directors in each of the selected schools were contacted by a member of the research team to solicit their participation in the study. In the event that a school was unable to participate in the study, appropriate substitutions were made from the list of alternate schools selected randomly for this purpose. Table 1 reveals the treatments, schools, instructors, and number of students who participated in the experiment.

Development of Instructional Techniques and Subject Matter Materials

Research team members were assigned an instructional technique and a subject matter area to study for use in the experiment. Their findings were evaluated by the research team and developed for use in the experimental schools. The subject matter areas selected for use in the study were units typically taught in vocational agriculture programs in Iowa at each grade level. Unit outlines and problem areas with behavioral objectives and references were developed by project staff members. Each problem area within each unit was assigned a day on which it was to be taught in the experimental schools. Teachers in all 48 schools had the same unit outlines and reference materials to follow during the experiment. Reference materials for part of the units were obtained from commercial sources while others were written by project staff members.

Development and Administration of Pre- and Post-Tests

Using the unit outlines and the reference materials developed for each of the subject matter areas, four pre-tests were developed by a project staff member who was unfamiliar with the materials being stressed through each of the instructional techniques. The questions on each test were developed to measure prior knowledge of the subject matter and were keyed to specific behavioral objectives stated in the problem area outlines. Questions on each test were derived from the reference materials studied in each unit.

The pre-tests were mailed to the guidance director in each of the experimental schools. On the day prior to the beginning of the experiment, the appropriate test was administered to each vocational agriculture class in the school. On the last day of the experiment, the guidance director in each school readministered the appropriate pre-test to each vocational agriculture class. This test served as the post-test.

The results of the post-test were submitted to an item analysis to determine the reliability of the pre- and post-tests. Post-test results were used to test for reliability because of a lack of available pre-test situations where the same units were taught in the same manner as was proposed in the project. The following reliability coeficients were derived from the item analyses on the post-test results: animal health, .85; commercial fertilizer, .85, small gasoline engines, .85; and farm credit, .87.

In addition to the student pre- and post-tests, four tests were developed by a project staff member and subject matter specialists at Iowa State University to measure the knowledge of the instructor in each of the subject matter areas included in the study. These tests were administered to the teachers participating in the study twice; once before the experiment began and again after the experiment had closed. Item analysis of the instructor post-tests provided the following reliability coefficients: animal health, .80; commercial fertilizer, .87; small gasoline engines, .85; and farm credit, .84.

Table 1. Treatments, schools, instructors and number of students participating in the study

Treatment	School	Instructor	Number of students				
			Animal health	Commercial fertilizer	Small gasoline engines	Farm credit	Total
Audio-tutorial	Atlantic	Ronald Beaver	12	12	13	10	47
	Edgewood	William Kenney	16	18	16	12	62
	New Hampton	Robert Bell	20	20	16	19	75
	Newton	Emeron Dettmann	14	13	16	10	53
	Sioux Center	William Godsey	17	15	18	19	69
	Sumner	John Scott	15	17	7	11	50
	Total		94	95	86	81	356
Demon-stration	Algona	George Sefrit	5	10	13	8	36
	Corning	Wayne Kordick	25	13	21	15	74
	Denison	Donald Swafford	19	18	15	8	60
	Lake City	Rudolph Engstrom	16	13	17	5	51
	Osage	Lewis Lauterbach	16	14	17	8	55
	Shenandoah	Allen Carrell	24	12	11	6	53
	Total		105	80	94	50	329
Field trip	Albert City	Allen Henigan	18	13	15	9	55
	Buffalo Center	Wayne Nattress	8	15	9	10	42
	Calmar	Wallace Reidel	20	16	17	22	64
	Eddyville	Donald Kent	15	12	13	9	49
	LaPorte City	Ronald Borton	7	16	22	9	54
	Liberty Center	Paul Blount	9	14	13	10	46
	Total		77	86	89	58	310
Prepared lesson plan	Earlham	Gerald Lamers	17	4	11	8	40
	Monticello	Grover Miehe	11	11	11	20	53
	Northeast (Goose Lake)	Edward Faselt	20	10	12	14	56
	Paullina	Paul Vincent	13	14	15	9	51
	Villisca	Dale Spencer	16	10	17	9	52
	Wilton Junction	Derwood Keith	14	14	7	11	46
	Total		91	63	73	71	298

Table 1 (continued)

Treatment	School	Instructor	Number of students				
			Animal health	Commercial fertilizer	Small gasoline engines	Farm credit	Total
Single concept film	Akron	John Ziniel	17	12	9	8	46
	Albia	Howard Willson	10	17	14	13	54
	Britt	Alan McFee	18	12	9	5	44
	Iowa Falls	Joe White	12	13	16	12	53
	Maquoketa Valley (Delhi)	Melvin Weber	19	15	14	16	64
	Mid Prairie (Wellman)	Paul Swank	14	22	17	10	63
	Total		90	91	79	64	324
Trans-parency	Alden	Duane Brouwer	12	10	11	11	44
	Anamosa	Ronald Ruess	18	12	15	14	59
	Guthrie Center	Wayne Calhoun	21	17	9	14	61
	Maurice-Orange City	Joseph Weed	10	10	11	11	42
	Pleasantville	Russell Johnson	10	11	12	14	47
	Sigourney	George Swearingen	8	17	12	13	50
	Total		79	77	70	77	303
Video-tape	Clarion	Hugh Townsend	12	17	18	18	65
	Eldridge	William Marsh	14	19	9	15	57
	Mediapolis	James Howell	27	17	15	20	79
	Waukon	Norbert Duffy	13	13	17	14	57
	West Branch	Francis Abel	13	8	15	8	44
	Winterset	John Bishop	14	12	15	8	49
	Total		93	86	89	83	351
Tradi-tional	Alta	Harold Carstens	12	7	8	8	35
	Everly	Dale Fisher	7	9	9	11	36
	Hartley	Harold Woodard	12	8	10	9	39
	Rock Valley	Donald Kaberna	10	9	8	10	37
	Sac City	Larry Reding	10	8	14	8	40
	West Liberty	Richard Wehde	16	10	10	9	45
	Total		67	51	59	55	232
Grand Total			696	629	639	539	2503

Collection of Student and Instructor Data

Prior to and during the field testing of the instructional techniques and resources, the following data was collected on the students and instructors to study the effects and interactions of these factors on the dependent variables. This information was collected by the school guidance director and relayed directly to project staff members at Iowa State University.

Student information

Otis Quick Scoring Mental Ability Test
Differential Aptitude Test–
Abstract Reasoning Section
Verbal Reasoning Section
Mechanical Reasoning Section
Kuder General Interest Survey–Form E
Nebraska Test of Agricultural Achievement
Crop acres on students' home farms
Total acres on students' home farms
Total animal units on students' home farms
Total number of brothers and sisters
Semesters of science completed
Semesters of mathematics completed
Semesters of vocational agriculture completed

Instructor information

Tenure in present school
Tenure in teaching vocational agriculture
Minnesota Teacher Attitude Inventory
Teacher knowledge of subject matter

School information

Class enrollments
Total enrollment in vocational agriculture program

Since the randomization process was applied to the experimental unit (schools) and not directly to students within schools, all comparisons using the above factors were made using treatment means derived from school means.

Training of Teachers

Two meetings of all teachers who participated in the project were held during the initial stages of the study. The first meeting explained in depth the purpose and design of the study, the controls imposed on the experiment, and the importance of each teacher adhering rigidly to these controls. During this meeting the instructor pre-tests were administered.

The second meeting was a training meeting held on the campus of Iowa State University. Teachers assigned to the different treatment groups met with the persons responsible for developing the instructional techniques and resources for their schools. During this meeting the teachers were familiarized with the instructional techniques and resources to be used in their schools, the instructional materials and equipment they were to use in implementing the instructional approaches, and were trained in the use of these materials and equipment.

Analysis of Data

All data collected on students was coded and transferred to 80 column IBM cards. School means were computed for each variable and used to derive treatment means upon which all analyses were made. The following statistical techniques were used in analyzing the data.

1. Means
2. Two-factor experiment with repeated measures
3. Stepwise regression analysis
4. Analysis of variance
5. Analysis of co-variance
6. Test for least significant difference

Models used in testing for significance are provided below.

Analysis of variance

$Y_{ij} = u + B_j + e_{ij}$

where:

Y_{ij} = any observation, i = l,. . . .6, j = l,. . . .8
u = mean of the observations
B_j = effect of the treatment
e_{ij} = random error
i = number of schools per treatment
j = number of treatments

Analysis of co-variance

$Y_{ij} = u + a_i + B_1 x_1 + B_2 x_2, \ldots\ldots\ldots B_k x_k + e_{ij}$

where:

Y_{ij} = class post-test mean scores
u = overall mean
a_i = treatment effect, i = 1,. . . .8
$B_1 x_1 = B_1$ = partial regression coefficient of Y on X_1
x_1 = deviation of the mean of X_{1ij} from the overall mean X_1. . . . . .
e_{ij} = random error

Two-factor experiment with repeated measures

$Y_{ijk} = u + a_1 + s_{ij} + B_k + (ab_{jk}) + e_{ijk}$

where:

Y_{ijk} = pre- and post-test class means
u = overall mean
a_i = effect of treatment, i = 1. . . .8
s_{ij} = effect of the jth class, ith treatment, j = 1,. . . .6
$B_k = B$ = effect of the repeated measure
k = 1 for pre-test, 2 for post-test
ab_{jk} = interaction k repeated measure within the jth treatment
e_{ijk} = random error

Stepwise regression

$Y_{ij} = B_o + B_1 x_1 + B_2 x_2 \ldots\ldots B_i x_i + e_{ij}$

where:

Y_{ij} = class post-test mean
B_o = intercept of vertical axis
$B_1 x_1 = B_1$ = partial regression coefficient of Y and X_1
x_1 = deviation of the mean of X_{1ij} from the overall mean X_1. . . . . .

FINDINGS

Due to the fact that different subject matter was used at each of the four grade levels and that achievement was measured with different pre- post-test instruments, the data were analyzed by grade levels. The findings presented henceforth are presented in parts corresponding to the subject matter studied at each grade level.

Part I – Animal Health

Data in Table 2 reveal the treatment means for each of the variables analyzed in the study. It was observed that the greatest difference between the pre- and post-test mean scores was for the control group and that this group had the highest post-test mean score. It was further observed that there existed a 12.30 point difference between the high (control) and low (demonstration) post-test group means when compared by treatment.

Analysis of the organismic variable means by treatment groups revealed that the control means tended to be in the middle of or lower than the means of the treatment groups. Comparisons of the concomitant variable means revealed that the control means tended to be in the middle of or lower than the means of the treatment groups. Comparisons of the concomitant variable means revealed rather large differences in favor of the control group for crop acres, total acres, and animal units on the students' home farms. For the variables dealing with enrollment and teacher tenure, the control group had the lowest means.

Ho_1 – *There are no significant differences among group pre-test mean scores in animal health*

The mean pre-test mean scores are presented in Table 2. It was observed among the treatment means that four were higher and three were lower than the control mean. The greatest difference between any two group means was observed to be 7.67 points, that being between the single concept film and video-tape groups.

An analysis of variance was computed on the eight group means to test for differences among groups using the model described in the preceding chapter. It was observed in Table 3 that a nonsignificant F-value of 2.0191 was derived and the null hypothesis stated above was not rejected.

Ho_2 – *There are no significant differences among group post-test mean scores in animal health*

The post-test mean scores classified by treatment group are presented in Table 2. Differences among group means were analyzed in Table 4. It was observed that a nonsignificant F-value of 1.7309 was derived as a result of the analysis of variance test. These findings support the null hypothesis that there were no differences among group post-test mean scores in animal health.

To ascertain whether differences existed among the combined treatment pre-test and post-test mean scores, treatment pre- and post-test scores and the effect of treatment on these differences, a two-factor experiment with repeated measures was conducted on the eight treatment groups. The model used to derive the statistics to test the above hypotheses was presented in the preceding chapter.

Data presented in Table 5 provide the results of this analysis. A nonsignificant F statistic of 1.9808 observed between groups caused failure to reject the null hypothesis that there were no differences among the combined treatment pre-test and post-test score differences. A similiar observation was made and conclusion drawn for the interaction between treatment and pre-post-test score differences. A highly significant, F statistic (433.9226) was observed, however, for treatment pre- and post-test score differences. In this case, the null hypothesis that there was no difference between treatment pre- and post-test scores was rejected and the alternate hypothesis that treatment pre- and post-test scores were different was accepted.

Table 2. Dependent, organismic, and concomitant variable treatment means in animal health

	Treatment means							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Dependent								
Pre-test	33.45	35.09	35.38	30.98	30.53	36.22	37.11	34.04
Post-test	48.06	54.27	52.94	50.11	45.71	55.96	54.63	57.57
Organismic								
Intelligence quotient	99.40	99.69	101.35	99.43	97.52	101.31	100.93	101.96
Differential Aptitude Test–								
Mechanical Reasoning	62.96	53.45	55.70	58.08	55.93	57.41	64.35	58.64
Abstract Reasoning	54.63	60.29	56.29	51.44	40.76	55.61	57.18	59.72
Verbal Reasoning	53.09	48.15	55.23	47.12	44.70	47.32	58.62	56.38
Agricultural achievement score	38.67	61.74	59.57	52.49	49.31	62.96	60.55	57.41
Kuder-Outdoor	71.67	71.93	75.31	70.71	71.63	77.29	67.71	70.53
Kuder-Mechanical	52.08	55.40	51.48	45.80	47.96	61.06	53.01	52.08
Kuder-Computational	50.94	50.62	45.72	51.73	50.82	50.88	42.74	52.08
Kuder-Scientific	36.21	32.25	34.43	34.46	37.96	33.80	31.98	34.98
Kuder-Persuasive	54.29	50.25	52.14	56.05	54.14	53.32	48.59	57.45
Kuder-Artistic	42.67	50.08	47.34	46.99	46.60	44.33	39.67	40.13
Kuder-Social Service	47.56	50.74	46.59	37.26	41.68	48.14	36.73	38.64
Kuder-Literary	51.73	49.42	53.39	51.25	56.26	52.49	44.00	46.54
Kuder-Clerical	59.22	66.88	56.51	51.83	65.09	61.74	53.62	47.92
Semesters of vocational agriculture	2.0	3.0	1.9	1.9	1.7	3.7	2.3	2.0
Semesters of science	1.5	2.4	1.9	1.8	1.7	2.7	1.7	1.9
Semesters of mathematics	1.9	2.5	1.9	1.9	1.8	2.6	2.0	2.0
Concomitant								
Crop acres in home farm	183.39	197.31	200.86	179.43	173.54	202.00	171.54	228.21
Noncrop acres in home farm	55.93	53.01	71.63	31.17	25.42	83.29	65.36	32.33

[a] T_1 = Audio-tutorial, T_2 = Demonstrations, T_3 = Field trips, T_4 = Prepared lesson plans, T_5 = Single concept films, T_6 = Overhead projected transparency, T_7 = Video-tape, T_8 = Traditional (control)

Table 2 (continued)

	Treatment means							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Total acres in home farm	235.06	245.03	275.70	204.25	202.14	265.62	223.54	260.55
Animal units in home farm	112.01	70.67	77.94	103.28	81.98	121.28	80.31	123.99
Total brothers and sisters	3.8	3.5	3.7	3.8	3.1	3.8	3.4	3.2
Class enrollment	15.67	16.83	13.00	15.17	15.00	13.17	15.50	11.50
Departmental enrollment	59.33	53.67	51.67	49.67	54.00	50.50	58.50	39.17
Teacher tenure in present school	9.7	17.3	6.2	9.0	9.3	8.0	10.7	4.8
Teacher tenure in teaching vocational agriculture	13.3	17.3	8.0	13.2	11.5	10.5	12.6	6.8
Teacher knowledge of subject matter	32.33	33.50	30.33	30.50	28.00	32.00	32.33	33.67
Minnesota Teacher Attitude Inventory	41.83	65.50	59.33	21.17	43.50	38.33	64.50	52.67

Table 3. Analysis of variance of pre-test scores by treatment group in animal healt ı

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	234.6797	33.5257	2.0191
Within groups	40	664.1602	16.604	
Total	47	898.8398		

[a]Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Table 4. Analysis of variance of post-test scores by treatment group in animal health

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	701.8828	100.269	1.7309
Within groups	40	2317.117	57.9279	
Total	47	3019.0		

[a]Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Ho_3 – *There are no significant differences among the combined treatment pretest and post-test mean scores in animal health*

Ho_4 – *There are no significant differences among treatment pre- and post-test mean scores in animal health*

Ho_5 – *There is no interaction among treatment and pre- and post-test mean score differences in animal health*

To analyze what factors could be most directly affecting the relationships between treatment post-test means, a stepwise regression analysis was conducted on all organismic and concomitant variables on which data had been collected. The stepwise regression model was identified and defined in the preceding chapter. In Table 6, the eight variables having the most influence on the post-test means are identified. It was observed that these eight variables accounted for .7586 percent of the variance among group means. Of this percentage, 88 percent was attributable to the agricultural achievement score, pre-test score, crop acres on the students' home farm, and teacher knowledge of subject matter.

Table 5. Two-factor experiment with repeated measure analysis of pre- and post-test mean scores in animal health

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F[a]
Between groups	7	770.2468	110.03524	1.9808
Error a	40	2240.25488	56.00636	
Pre- post-test difference	1	8044.453125	8044.45313	433.9226**
Interaction between treatment and test differences	7	166.2286	23.74695	1.2809
Error b	40	741.55639	18.53891	
Total	95	11962.7461		

[a]Table value at the .01 level with one and 40 degrees of freedom was 7.31. Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Ho_6 – *There are no significant differences among treatment mean scores in animal health when controled on crop acres on home farm, agricultural achievement score, pre-test score, and teacher knowledge of subject matter*

Using the data provided in Table 6, an analysis of covariance test was conducted on the post-test scores controlling on crop acres on home farm, agricultural achievement score, pre-test score, and teacher knowledge of subject matter. The analysis of covariance model used to test for these differences was presented and described in the preceding chapter. The results of this test are provided in Table 8. A nonsignificant F-value of .312 revealed no differences among groups when controlling for these variables and the null hypothesis stated above was accepted.

Using the beta values derived through the analysis of covariance test, adjusted means were computed to analyze what differences occurred between groups when controlling on the above variables. The adjusted means are presented in Table 8. It was observed that five of the group means decreased in value, whereas three group means had increased in value. In all comparisons between treatment and control means, the adjusted control mean was higher than the adjusted treatment mean. It was further observed that in those treatment groups that involved a high degree of independent student study, the adjusted mean was higher than the unadjusted mean. For those treatment groups that were oriented to group instruction, the adjusted mean was lower than the unadjusted mean. As was revealed in Table 7, however, these differences were not significantly different. Pre-test and agricultural achievement scores accounted for the majority of the adjustment between group means.

Part II – Commercial Fertilizer

The treatment dependent, organismic, and concomitant variable means for the commercial fertilizer unit are presented in Table 9. It was observed that the greatest difference between pre- and post-test mean scores was for the single concept film group. The field trip group had the highest pretest mean score and control had the highest post-test mean score. It was further observed that there existed a 9.54 point difference between the high (control) and low (audio-tutorial) post-test group means when compared by treatment.

Table 6. Stepwise regression analysis of organismic and concomitant variables (X) on the dependent variable post-test (Y) in animal health (F-value to enter or remove = 3.00)

Step	Activity	Variable	Multiple R	F
1	Enter	Agricultural achievement score	.4137	3.629
2	Enter	Pre-test score	.5084	13.243
3	Enter	Crop acres on home farm	.5883	5.9835
4	Enter	Intelligence quotient	.6327	
5	Enter	Teacher knowledge of subject matter	.6606	4.976
6	Enter	Kuder-Persuasive	.6927	11.766
7	Remove	Intelligence quotient	.6779	
8	Enter	Kuder-Artistic	.7126	6.664
9	Enter	Differential Aptitude Test-Abstract Reasoning Section	.7396	3.513
10	Enter	Kuder-Literary	.7586	3.065

Table 7. Analysis of covariance for post-test differences among groups in animal health controlling for crop acres on home farm, agricultural achievement score, pre-test score, and teacher knowledge of subject matter

Source of variation	Residuals			
	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	63.825	9.118	.312
Error	36	1051.291	29.203	

[a]Table value at the .05 level with 7 and 36 degrees of freedom was 2.28.

Table 8. Animal health treatment means adjusting for differences due to pre-test score, crop acres on home farm, agricultural achievement score, and teacher knowledge of subject matter

Treatment	Unadjusted mean	Adjusted mean
Audio-tutorial	48.06	51.98
Demonstration	54.27	51.26
Field trip	52.94	51.38
Prepared lesson plan	50.11	53.72
Single concept film	45.71	51.59
Overhead projected transparency	55.96	52.47
Video-tape	54.63	51.05
Traditional (control)	57.57	54.85

Table 9. Dependent, organismic, and concomitant variable treatment means in commercial fertilizer

Variable	Treatment means							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Dependent								
Pre-test	29.23	31.28	33.43	31.66	29.48	30.33	27.46	36.62
Post-test	38.72	43.38	48.15	44.87	46.30	47.12	44.02	48.26
Organismic								
Intelligence quotient	93.58	101.35	101.90	100.36	100.00	102.56	96.99	104.20
Differential Aptitude Test—								
Mechanical Reasoning	56.95	56.65	54.40	52.16	51.71	58.54	55.68	65.84
Abstract Reasoning	50.41	59.95	54.30	59.62	55.82	65.38	53.67	73.44
Verbal Reasoning	41.34	52.49	53.85	51.05	46.23	57.78	52.78	59.15
Agricultural achievement score	33.61	52.20	59.87	57.94	62.18	60.02	61.36	62.14
Kuder-Outdoor	67.89	69.13	81.39	68.00	74.91	78.40	72.25	74.00
Kuder-Mechanical	49.37	53.14	54.59	40.51	55.44	60.89	50.82	57.12
Kuder-Computational	44.12	49.88	45.77	59.30	52.58	48.85	39.96	47.67
Kuder-Scientific	32.43	34.14	33.13	35.34	39.49	40.42	34.47	37.51
Kuder-Persuasive	44.13	60.47	55.99	50.40	52.73	49.71	50.21	53.67
Kuder-Artistic	39.56	50.91	45.42	42.73	42.30	46.84	46.44	48.99
Kuder-Literary	45.68	52.87	50.33	51.68	49.64	37.96	51.53	48.73
Kuder-Social Service	41.85	45.52	42.45	43.64	46.80	43.96	50.99	40.98
Kuder-Clerical	59.53	63.69	60.35	60.90	58.03	52.88	54.67	56.01
Semesters of science	2.6	2.5	3.4	2.4	3.2	2.7	2.6	2.7
Semesters of mathematics	2.3	2.4	2.7	2.5	2.6	2.2	3.2	3.0
Semesters of vocational agriculture	3.3	2.8	3.6	3.3	3.6	2.8	3.8	3.6
Concomitant								
Crop acres on home farm	188.80	226.78	174.73	144.56	193.97	204.03	188.87	236.98
Noncrop acres on home farm	44.41	65.57	69.30	37.55	58.27	70.24	57.10	51.29

[a] T_1 = Audio-tutorial, T_2 = Demonstrations, T_3 = Field trips, T_4 = Prepared lesson plans, T_5 = Single concept films, T_6 = Overhead projected transparency, T_7 = Video-tape, T_8 = Traditional (control)

Table 9 (continued)

Variable	Treatment means							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Total acres on home farm	232.96	284.17	216.30	182.64	234.26	264.47	243.94	289.79
Animal units on home farm	101.91	100.82	97.02	69.28	71.90	94.13	93.48	186.58
Total brothers and sisters	3.7	3.7	4.1	3.6	4.3	3.4	4.0	3.6
Class enrollment	15.83	13.50	13.67	10.50	15.17	12.83	14.33	8.8
Departmental enrollment	59.33	53.67	51.67	49.67	54.00	50.50	58.50	39.17
Teacher tenure in present school	9.7	17.3,	6.2	9.0	9.3	8.0	10.7	4.8
Teacher tenure in teaching vocational agriculture	13.3	17.3	8.0	13.2	11.5	10.5	12.6	6.8
Teacher knowledge of subject matter	33.83	34.17	29.33	28.50	28.33	31.17	30.83	33.50
Minnesotal Teacher Attitude Inventory	41.83	65.50	59.33	21.17	43.50	38.33	64.50	52.67

Analysis of the organismic variable means stratified by treatment groups revealed that for the variables dealing with student achievement and aptitude, the control group had the highest mean scores. For the remaining variables, the control means tended to be in the middle of or lower than the treatment means. Comparisons of the concomitant variables revealed that the control group had the highest mean for crop acres in home farm, total crop acres, and animal units on the students' home farms. For the variables dealing with enrollment and teacher tenure, the control group had the lowest mean scores.

Ho_7 – *There are no significant differences among group pre-test mean scores in commercial fertilizer*

An analysis of variance test was conducted on the pre-test means presented in Table 9 to test for differences among group means. The results of this test are presented in Table 10. The nonsignificant F-value of 1.4046 revealed no differences and the null hypothesis was not rejected.

Table 10. Analysis of variance of pre-test mean scroes by treatment group in commercial fertilizer

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	188.691	26.956	1.405
Within groups	40	767.65	19.191	
Total	47	956.344		

[a]Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Ho_8 – *There are no significant differences among group post-test mean scores in commercial fertilizer*

The mean post-test scores presented in Table 9 were tested for differences using the same technique used to test for differences among pre-test scores. It was observed in Table 11 that an F statistic of .7853 was derived from this test and the null hypothesis that there were no differences among group post-test mean scores in commercial fertilizer was accepted.

Table 11. Analysis of variance of post-test mean scores by treatment group in commercial fertilizer

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	418.254	59.751	.7853
Within groups	40	3043.308	76.083	
Total	47	3461.562		

[a]Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Ho_9 – *There are no significant differences among the combined treatment pre-test and post-test mean scores in commercial fertilizer*

Ho_{10} – *There are no significant differences among treatment pre- and post-test mean scores in commercial fertilizer*

Ho_{11} – *There is no interaction among treatment and pre- post-test mean score differences in commercial fertilizer*

A two-factor experiment with repeated measures was conducted on the treatment group means to test the above hypotheses. It was observed in Table 12 that no differences existed among the combined treatment pre-test and post-test mean scores and in the interaction between treatment groups and test differences causing the acceptance of Ho_9 and Ho_{11}. A highly significant (significant at the .01 level) F-value of 249.81 was observed for treatment pre- and post-test differences. The null hypothesis that there was no difference between treatment pre- and post-test scores was rejected and the alternate hypothesis that the treatment pre- and post-test scores were different was accepted.

A stepwise regression analysis was conducted on the organismic and concomitant variables using the post-test as the Y variable to identify those variables most directly affecting the differences between the treatment post-test means. The results of this analysis are presented in Table 13. It was observed that 13 variables accounted for 88 percent of the variance and that six of these variables accounted for 89 percent of this variance. Included among those five variables were the pre-test score, Differential Aptitude Test–Abstract Reasoning, Kuder-Social Service, Kuder-Clerical, and semesters of vocational agriculture.

Ho_{12} – *There are no significant differences among treatment mean post-test scores in commercial fertilizer controlling on crop acres on home farm, Differential Aptitude Test–Abstract Reasoning, and pre-test scores.*

Table 12. Two-factor experiment with repeated measures analysis of pre- and post test mean scores in commercial fertilizer

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	465.511	66.501	.8789
Error a	40	3026.526	75.663	
Pre- and post-test mean differences	1	4901.016	4901.016	249.815**
Interaction between treatment and test differences	7	141.317	20.188	1.029
Error b	40	784.745	19.619	
Total	95	9319.121		

[a]Table value at the .01 level with one and 40 degrees of freedom was 7.31. Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Table 13. Stepwise regression analysis of organismic and concomitant variables (X) on the dependent variable post-test (Y) in commercial fertilizer (F value to enter or remove = 3.000)

Step	Activity	Variable	Multiple R	F
1	Enter	Pre-test score	.4972	18.290
2	Enter	Agricultural achievement score	.6202	
3	Enter	Differential Aptitude Test–Abstract Reasoning Section	.6840	40.584
4	Enter	Kuder-Social Service	.7323	24.762
5	Enter	Kuder-Clerical	.7612	20.913
6	Enter	Semesters of vocational agriculture	.7911	24.789
7	Enter	Teacher tenure in present school	.8131	3.605
8	Enter	Crop acres on home farm	.8348	8.417
9	Remove	Agricultural achievement score	.8235	
10	Enter	Kuder-Scientific	.8419	
11	Enter	Kuder-Artistic	.8572	6.762
12	Enter	Kuder-Mechanical	.8698	7.350
13	Remove	Kuder-Scientific	.8611	
14	Enter	Kuder-Computational	.8792	6.129
15	Enter	Kuder-Scientific	.8887	3.071

An analysis of co-variance test was conducted on the group means controlling for crop acres on home farm, Differential Aptitude Test–Abstract Reasoning, and pre-test scores. Selection of the above co-variates was based on data provided in Table 13. The results of this test are provided in Table 14.

An F-statistic of 2.46 was derived from the analysis of co-variance test described above. An F-value of 2.27 was required for significance at the .05 level of confidence. The null hypothesis was rejected and the alternate hypothesis that there were differences among treatment mean post-test scores in commercial fertilizer when controlling on crop acres on home farm, Differential Aptitude Test–Abstract Reasoning and pre-test scores was accepted.

Adjusted means, when equated for differences due to the co-variates described in Ho_{12}, are provided in Table 15. It was observed that all adjusted treatment means were higher than the adjusted control mean. The highest adjusted mean was observed for the video-tape group (50.75) and the greatest adjustment between the original and adjusted mean occurred for the control group (11.23). For all but two (demonstration and overhead projected transparency) treatment groups, the adjusted mean was higher than the unadjusted mean. The variables causing the greatest adjustment in means were found to be Differential Aptitude Test–Abstract Reasoning and pre-test scores.

Table 14. Analysis of co-variance for post-test differences among treatments in commercial fertilizer controlling for Differential Aptitude Test–Abstract Reasoning, pre-test score, and crop acres on students' home farms

Source of variation	Residuals			
	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	413.431	59.062	2.46*
Error	37	887.123	23.976	

[a]Table value at the .05 level with 7 and 37 degrees of freedom was 2.27.

To determine which of the treatment means were significantly different, a least significant difference test was made on all mean differences. The mean differences and the test results are presented in Table 16. It was observed that the mean differences for the field trip, single concept film, and video-tape groups exceeded the least significant difference value of 9.60.

Table 15. Commercial fertilizer treatment means adjusting for differences due to Differential Aptitude Test–Abstract Reasoning, pre-test score and crop acres on students' home farms.

Treatment	Unadjusted mean	Adjusted mean
Audio-tutorial	38.72	43.15
Demonstration	43.38	41.44
Field trip	48.15	48.24
Prepared lesson plan	44.87	46.02
Single concept film	46.30	48.54
Overhead projected transparency	47.12	45.09
Video-tape	44.02	48.85
Traditional (control)	48.26	37.03

Table 16. Least significant differences between adjusted treatment means in commercial fertilizer

	Treatment[a]						
Treatment	2	3	4	5	6	7	8
1	4.41	6.12	8.06	8.99	11.23*[b]	11.51*	11.82**
2		1.71	3.63	4.58	6.80	7.10	7.41
3			1.94	2.87	5.09	5.39	5.70
4				.93	3.15	3.45	3.76
5					2.22	2.52	2.83
6						.30	.61
7							.31

[a]Treatment numbers represent the following: 1 = control, 2 = demonstration, 3 = audio-tutorial, 4 = overhead projected transparency, 5 = prepared lesson plan, 6 = field trip, 7 = single concept film, 8 = video-tape.

[b]Least significant difference was 9.60.

Part III – Small Gasoline Engines

Comparisons of the pre-test mean scores by treatment group in Table 17 revealed that the control group mean was lowest and that a 6.52 mean difference existed between the high (audio-tutorial group) and low (control) means. Similar comparisons made between the post-test mean scores revealed, however, that the control group had the high mean (68.44) whereas the video-tape group had the low mean (58.88) and that a difference of 9.56 points existed between these two means.

Comparisons between the organismic variables dealing with student achievement and aptitude revealed that with the exception of the Differential Aptitude Test–Mechanical Reasoning, the control group had the highest means. For the Differential Aptitude Test–Mechanical Reasoning variable, the control group had the second lowest group mean. Analysis of the concomitant variables revealed that the control group had the highest mean for crop acres, total acres, and animal units on the students' home farms. For the variables dealing with enrollment and teacher tenure, the control group had the lowest mean scores.

Ho_{13} – *There are no significant differences among group pre-test mean scores in small gasoline engines*

Table 17. Dependent, organismic, and concomitant variable treatment means in small gasoline engines

Variable	Treatment means[a]							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Dependent								
Pre-test	44.93	40.41	40.28	43.08	41.23	40.54	41.33	38.42
Post-test	62.92	63.08	61.47	63.83	61.89	63.44	58.88	68.44
Organismic								
Intelligence quotient	99.09	101.28	99.09	102.31	98.76	100.17	100.35	104.72
Differential Aptitude Test–								
Mechanical Reasoning	56.91	51.86	54.54	55.96	50.38	48.49	54.50	51.14
Abstract Reasoning	46.18	53.99	57.84	48.90	53.97	52.04	44.08	60.85
Verbal Reasoning	43.27	49.02	47.36	46.44	44.09	47.03	38.61	52.60
Agricultural achievement score	47.70	57.71	59.74	62.31	55.04	59.45	52.86	61.26
Kuder-Outdoor	65.59	71.84	77.88	66.58	75.61	74.22	68.50	74.29
Kuder-Mechanical	49.19	57.73	59.72	55.56	59.18	60.53	50.76	51.58
Kuder-Computational	47.55	52.95	50.61	50.26	50.74	48.63	44.96	51.64
Kuder-Scientific	32.74	33.43	33.96	34.55	37.90	33.97	30.33	31.42
Kuder-Persuasive	45.97	53.85	55.93	51.17	54.17	57.26	44.56	58.75
Kuder-Artistic	41.79	52.49	42.65	47.85	46.46	44.46	42.80	44.10
Kuder-Literary	46.64	44.70	46.03	47.03	48.54	44.87	45.10	47.85
Kuder-Social Service	44.13	48.24	49.20	45.20	45.38	53.94	41.92	50.52
Kuder-Clerical	59.72	61.63	59.41	58.38	60.66	56.96	53.93	56.90
Semesters of science	3.0	3.2	3.6	2.7	3.9	3.7	3.0	3.6
Semesters of mathematics	3.5	3.5	3.4	3.3	3.4	3.7	3.2	3.8
Semesters of vocational agriculture	5.1	5.1	5.4	5.3	5.4	6.2	4.6	5.6
Concomitant								
Crop acres on home farm	164.85	213.55	245.37	173.48	230.89	201.63	191.35	267.94
Noncrop acres on home farm	38.63	56.43	60.33	56.79	71.94	63.33	63.68	58.63

[a] T_1 = Audio-tutorial, T_2 = Demonstration, T_3 = Field trip, T_4 = Prepared lesson plans, T_5 = single concept films, T_6 = Overhead projected transparency, T_7 = Video-tape, T_8 = Traditional (control)

Table 17 (continued)

Variable	Treatment means							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Total acres on home farm	203.48	271.97	304.91	199.62	274.23	239.99	237.16	279.07
Animal units on home farm	96.73	68.67	114.39	122.36	84.47	121.31	92.83	249.93
Total brothers and sisters	3.8	3.2	3.6	3.7	4.8	3.6	3.3	3.0
Class enrollment	14.33	14.00	14.67	12.17	13.17	11.67	14.83	9.67
Departmental enrollment	59.33	53.67	51.67	49.67	54.00	50.50	58.50	39.17
Teacher tenure in present school	9.7	17.3	6.2	9.0	9.3	8.0	10.7	4.8
Teacher tenure in teaching vocational agriculture	13.3	17.3	8.0	13.2	11.5	10.5	12.6	6.8
Teacher knowledge of subject matter	31.00	10.17	23.00	25.33	27.17	31.17	30.17	31.50
Minnesota Teacher Attitude Inventory	41.83	65.60	59.33	21.17	43.50	38.33	64.50	52.67

To determine whether the differences among the treatment pre-test means presented in Table 17 were significant, they were submitted to an analysis of variance test. The results of this test are presented in Table 18. A nonsignificant F-statistic of .4676 was derived from this test and the null hypothesis that there were no differences among group pre-test scores in small gasoline engines was accepted.

Table 18. Analysis of variance of pre-test mean scores by treatment group in small gasoline engines

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	162.160	23.1657	.4676
Within groups	40	1981.562	49.5413	
Total	47	21843.812		

[a]Table value at .05 level with 7 and 40 degrees of freedom was 2.25.

Ho_{14} – *There are no significant differences among group post-test mean scores in small gasoline engines*

It was observed in Table 17 that the greatest difference among group means was 9.56 points and that this difference existed between the video-tape and control groups. To determine whether this or other mean differences were significantly different, the group mean post-test scores were also submitted to an analysis of variance test. The results of this test, presented in Table 19, revealed a nonsignificant F-value of 1.02 and the null hypothesis as stated was accepted.

Table 19. Analysis of variance of post-test mean scores by treatment group in small gasoline engines

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	309.1602	44.1657	1.02
Within groups	40	1728.714	43.218	
Total	47	2037.875		

[a]Table value at .05 level with 7 and 40 degrees of freedom was 2.25.

Table 20. Two-factor experiment with repeated measure analysis of pre- and post-test mean scores in small gasoline engines

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	155.556	22.222	.344
Error a	40	2579.312	64.483	
Pre- and post-test mean differences	1	11315.617	11315.617	399.781
Interaction between treatment and test differences	7	315.556	45.079	1.593
Error b	40	1132.182	28.305	
Total	95	15498.227		

[a]Table value at the .01 level with one and 40 degrees of freedom was 7.31. Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Table 21. Stepwise regression analysis of organismic and concomitant variables (X) on the dependent variable post-test (Y) in small gasoline engines (F-value to enter or remove = 3.000)

Step	Activity	Variable	Multiple R	F
1	Enter	Agricultural achievement score	.3537	20.050
2	Enter	Intelligence quotient	.4677	12.644
3	Enter	Non-crop acres on home farm	.5324	7.161
4	Enter	Semesters of vocational agriculture	.5821	5.855
5	Enter	Teacher knowledge of subject matter	.6235	4.614

Ho_{15} – *There are no significant differences among the combined treatment pre-test and post-test mean scores in small gasoline engines in small gasoline engines*

Ho_{16} – *There are no significant differences among treatment pre- and post-test mean scores in small gasoline engines*

Ho_{17} – *There is no interaction between treatment and pre- post-test mean score differences in small gasoline engines*

Through the use of a two-factor experiment with repeated measures, it was observed that there were no differences among the combined treatment pre-test and post-test mean scores and no interaction between treatment and pre- post-test score differences in small gasoline engines. Evidence to support these conclusions is provided in Table 20 and Ho_{15} and Ho_{17} as stated above were accepted. The hypothesis that there were no differences between treatment pre- and post-test scores in small gasoline engines stated above was rejected and the alternate hypothesis accepted when a highly significant (significant at the .01 level) F-value of 399.781 was observed.

Data presented in Table 21 reveal the organismic and concomitant variables accounting for the majority of the variance between group means. As was the case of earlier comparisons, the Y variable was the post-test score. It was observed that five variables accounted for 62 percent of

the variance among group means and that each of these variables contributed s gnificantly to the variance. Accounting for the largest part of the variance were the agricultural achievement score, intelligence quotient, and noncrop acres on the students' home farms.

Ho_{18} –*There are no significant differences among treatment mean post-test scores in small gasoline engines controlling for teacher knowledge of subject matter, semesters of vocational agriculture, non-crop acres on home farm, Kuder-Social Service, agricultural achievement score, and intelligence quotient*

Table 22. Analysis of co-variance for post-test differences among treatments in small gasoline engines controlling for teacher knowledge of subject matter, semesters of vocational agriculture, non-crop acres on home farm, Kuder-Social Service, agricultural achievement score, and intelligence quotient

Soucre of variation	Residuals			
	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	126.065	18.009	1.036
Error	34	591.315	17.392	

[a]Table value at the .05 level with 7 and 34 degrees of freedom was 2.30.

An analysis of co-variance test was conducted on the mean post-test scores in small gasoline engines controlling for the variables described in the above hypothesis. The results of this test are presented in Table 22. A non-significant F-value of 1.036 was derived from this test and the null hypothesis was accepted.

Adjusted post-test mean scores in small gasoline engines were computed using the beta values derived through the analysis of co-variance test in Table 22. The unadjusted and adjusted means are presented in Table 23. It was observed that the adjusted means for the audio-tutorial, field trip, single concept film, and video-tape groups were higher than the unadjusted means. It was further observed that three adjusted group means (audio-tutorial, field trip, and single concept film) were higher than the control mean where originally the control mean was higher than any of the treatment means. While these changes in means reflect differences after equating for variable differences in Table 23, they are not significantly different as was observed in Table 22. Those co-variates observed to be contributing most to the adjustment of the treatment and control means were agricultural achievement score, intelligence quotient, and teacher knowledge of the subject matter.

Table 23. Small gasoline engines treatment means adjusting for differences due to teacher knowledge of subject matter, semesters of vocational agriculture, non-crop acres on home farm, Kuder-Social Service, agricultural achievement score, and intelligence quotient

Treatment	Unadjusted mean	Adjusted mean
Audio-tutorial	62.92	67.46
Demonstration	63.08	62.01
Field trip	61.47	63.94
Prepared lesson plan	63.83	63.71
Single concept film	61.89	65.77
Overhead projected transparency	63.44	60.25
Video-tape	58.88	62.45
Traditional (control)	68.44	63.51

Part IV – Farm Credit

Data in Table 24 reveal the group means for the dependent, organismic, and concomitant variables in farm credit. For both the pre-test and post-test, the control group had the high mean score and the audio-tutorial group had the low mean score. A difference of 7.75 points existed between the high and low pre-test scores and a difference of 9.37 points existed between the high and low post-test mean scores.

Comparisons of mean scores for the organismic variables revealed that the control group mean tended to be in the middle of or higher than the treatment mean scores. This was particularly evident for intelligence quotient, Differential Aptitude Test–Mechanical, Verbal, and Abstract Reasoning mean scores. The opposite was observed for the agricultural achievement scores. In this case, the control group mean was well below the majority of the treatment groups. As was observed for the concomitant variables in the other subject matter areas, the control group had the high mean for crop acres, total acres, and animal units on the students' home farms. Similarly, for the variable dealing with enrollment and teacher tenure the control schools had the low group means.

Ho_{19} – *There are no significant differences among group pre-test mean scores in farm credit*

Data in Table 25 provide the results of an analysis of variance test to detect significant differences among pre-test scores in farm credit. An F-value of .88 revealed no difference among group pre-test mean scores and the hypothesis was accepted.

Ho_{20} – *There are no significant differences among group post-test mean scores in farm credit*

It was observed in Table 24 that a 9.37 point difference existed between the high (control) and low (audio-tutorial) group means. Data in Table 26 provide the results on an analysis of variance test to determine whether this difference and other differences between treatment means were significantly different. The resulting F-value of .94 revealed that these differences were not significant and the hypothesis stated above was accepted.

Ho_{21} – *There are no significant differences among the combined treatment pre-test and post-test mean scores in farm credit*

Ho_{22} – *There are no significant differences among treatment pre- and post-test mean scores in farm credit*

Ho_{23} – *There is no interaction between treatment and pre- post-test mean score differences in farm credit*

To determine whether differences existed among the combined treatment pre-test and post-test mean scores, treatment pre- and post-test scores and the effect of treatment on these differences, a two-factor experiment with repeated measures was conducted on the eight treatment groups.

Data in Table 27 revealed non-significant F-statistics between groups (.83) and the interaction between treatment and test score differences (1.307). Based on these observations Ho_{21} and Ho_{23} were accepted as stated above. A highly significant F-statistic (200.14) for pre- and post-test mean differences caused rejection of Ho_{22} and the alternate hypothesis that there were differences between treatment pre- and post-test mean scores was accepted.

Following the same procedure in analyzing the relationship of the organismic and concomitant variables to the post-test scores as was carried out in the other subject matter areas, a stepwise regression analysis was made to determine those variables most directly affecting the variance among group means. These variables are identified in Table 28. Only four variables were identified through this statistical procedure and they accounted for 68 percent of the variance among group means. All variables contributed significantly to the total variance among groups as was reflected by the F-values derived for each variable.

Table 24. Dependent, organismic, and concomitant variable treatment in farm credit

Variable	Treatment means							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Dependent								
Pre-test	40.65	44.25	51.52	46.00	44.55	40.73	47.13	48.39
Post-test	55.07	59.49	62.40	57.16	57.19	62.06	63.22	64.44
Organismic								
Intelligence quotient	99.35	101.98	104.65	101.92	100.10	103.53	105.65	104.77
Differential Aptitude Test—								
Mechanical Reasoning	44.84	45.09	54.26	54.62	44.53	52.82	50.10	52.37
Abstract Reasoning	44.63	46.28	59.02	59.35	41.19	55.04	57.48	62.26
Verbal Reasoning	37.56	39.57	47.75	47.45	42.84	46.43	43.58	45.47
Agricultural achievement score	45.49	72.06	77.66	69.10	57.57	62.05	71.67	69.36
Kuder-Outdoor	63.23	72.09	75.20	68.46	72.09	77.67	70.61	75.21
Kuder-Mechanical	48.76	52.42	62.92	58.61	55.29	63.29	50.87	65.08
Kuder-Computational	40.24	54.72	49.65	51.65	53.64	52.44	49.27	53.32
Kuder-Scientific	28.21	36.65	37.05	36.52	31.79	32.43	35.15	41.56
Kuder-Persuasive	48.27	52.05	50.54	53.79	52.43	49.72	44.61	50.08
Kuder-Artistic	43.47	47.52	41.74	44.25	47.62	46.99	38.79	42.11
Kuder-Literary	42.30	45.67	41.26	46.65	51.90	41.42	37.16	34.70
Kuder-Social Service	45.85	47.09	55.76	50.17	46.94	45.09	47.26	48.05
Kuder-Clerical	52.67	65.65	52.33	57.22	59.70	60.40	49.17	59.87
Semesters of science	3.4	3.9	4.8	3.3	3.9	4.1	4.1	3.6
Semesters of mathematics	3.7	4.1	4.1	3.6	3.8	3.6	4.7	4.5
Semesters of vocational agriculture	7.0	7.5	7.2	6.4	6.9	6.9	6.6	7.2
Concomitant								
Crop acres on home farm	191.40	188.65	239.02	166.35	205.84	184.60	200.30	259.48
Non-crop acres on home farm	55.44	44.16	66.97	51.08	53.30	55.60	69.55	49.72

[a] T_1 = Audio-tutorial, T_2 = Demonstration, T_3 = Field trip, T_4 = Prepared lesson plan, T_5 = Single concept film, T_6 = Overhead projected transparency, T_7 = Video-tape, T_8 = Traditional (control)

Table 24 (continued)

Variable	Treatment means							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Total acres on home farm	230.18	231.82	287.34	218.87	246.31	229.09	264.42	309.21
Animal units on home farm	108.94	84.51	135.00	92.76	60.89	118.38	64.32	158.24
Total brothers and sisters	3.5	2.9	3.3	3.9	3.8	3.3	3.4	3.2
Class enrollment	13.50	9.3	10.3	11.8	10.7	12.8	13.8	9.2
Departmental enrollment	59.33	53.67	51.67	49.67	54.00	50.50	58.50	39.17
Teacher tenure in present school	9.7	17.3	6.2	9.0	1.3	8.0	10.7	4.8
Teacher tenure in teaching vocational agriculture	13.3	17.3	8.0	13.2	11.5	10.5	12.6	6.8
Teacher knowledge of subject matter	31.83	32.67	30.50	27.83	26.33	27.17	29.50	29.33
Minnesota Teacher Attitude Inventory	41.83	65.50	59.33	21.17	43.50	38.33	64.50	52.67

Table 25. Analysis of variance of pre-test mean scores by treatment group in farm credit

Source of varition	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	577.234	82.462	.88
Within groups	40	3752.765	93.819	
Total	47	4330.0		

[a]Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Table 26. Analysis of variance of post-test mean scores by treatment group in farm credit

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	483.141	69.02	.94
Within groups	40	2952.171	73.804	
Total	47	3435.312		

[a]Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Table 27. Two-factor experiment with repeated measures analysis of pre- and post-test mean scores in farm credit

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	822.085	117.445	.83
Error a	40	5665.707	141.643	
Pre- and post-test mean score differences	1	5204.527	5204.527	200.104**
Interaction between treatment and test differences	7	238.045	34.006	1.307
Error b	40	1040.365	26.009	
Total	95	12970.7301		

[a]Table value at the .01 level with 1 and 40 degrees of freedom was 7.31. Table value at the .05 level with 7 and 40 degrees of freedom was 2.25.

Table 28. Stepwise regression analysis of organismic and concomitant variables (X) on the dependent variable post-test (Y) in farm credit (F-value to enter or remove = 3.000)

Step	Activity	Variable	Multiple R	F
1	Enter	Intelligence quotient	.4610	18.772
2	Enter	Pre-test	.5919	14.634
3	Enter	Kuder-Clerical	.6345	6.584
4	Enter	Teacher tenure in teaching vocational agriculture	.6805	6.1908

Ho_{24} – *There are no significant differences among treatment post-test mean scores in farm credit controlling for teacher enure in teaching vocational agriculture, intelligence quotient, Kuder-Clerical, and pre-test score*

Based on the data presented in Table 28, an analysis of co-variance test was conducted on the farm credit post-test mean scores controlling for teacher tenure in teaching vocational agriculture, intelligence quotient, Kuder-Clerical, and pre-test scores. The results of this test are presented in Table 29. A non-significant F-value of .633, derived as a result of this test, revealed non-significant differences between group post-test means and the hypothesis was accepted as stated above.

Table 29. Analysis of co-variance for post-test differences among treatments in farm credit controlling for intelligence quotient, Kuder-Clerical, teacher tenure in teaching vocational agriculture, and pre-test score

Source of variation	Residuals			
	Degrees of freedom	Sum of squares	Mean square	F[a]
Between groups	7	126.401	18.057	.633
Error	36	1027.393	28.539	

[a]Table value at the .05 level with 7 and 36 degrees of freedom was 2.28.

Adjusted means were computed for each treatment group equating for differences due to the co-variates identified in Ho_{24}. It was observed that except for the prepared lesson plan and field trip groups, the adjusted treatment means were higher than the adjusted control mean. It was further observed that except for the field trip, video-tape, and control groups, the adjusted means were higher than the original means. Intelligence quotient and pretest score were the two variables largely responsible for the differences between the unadjusted and adjusted means. These observations were made from the data presented in Table 30.

Table 30. Farm credit treatment means adjusting for differences due to intelligence quotient, Kuder-Clerical, teacher tenure in teaching vocational agriculture, and pre-test score

Treatment	Unadjusted mean	Adjusted mean
Audio-tutorial	55.07	61.76
Demonstration	59.49	60.95
Field trip	62.40	58.99
Prepared lesson plan	57.16	57.79
Single concept film	57.19	59.87
Overhead projected transparency	62.06	62.97
Video-tape	63.22	62.76
Traditional (control)	64.44	59.82

CONCLUSIONS AND IMPLICATIONS

The purpose of this study was to investigate the effectiveness of selected techniques and resources on instruction in vocational agriculture. The study compared seven "pilot" programs of teaching vocational agriculture with a "control" group, with all eight groups incorporated into an experimental design. In light of this purpose, the study did analyze the effectiveness of the eight instructional approaches in teaching vocational agriculture within the limitations of the study. The experimental design proved to be appropriate in analyzing these techniques and provided information upon which definite conclusions could be drawn concerning the data collected.

Analysis of the pre-test mean scores by treatment groups revealed differences between group means in all subject matter areas. The greatest difference (9.22 points) occurred in the commercial fertilizer unit between the video-tape and control groups. When these differences were tested using the analysis of variance technique, no significance was observed and it was concluded that all of the eight treatment groups were essentially equal in knowledge of the subject matter at the beginning of the experiment. One might suggest that these findings were due to the homogeneous background of the students included in the study. However, when stepwise regression analyses were conducted on the organismic and concomitant variables to identify those variables having the greatest influence on the post-test variance among treatment group means, it was observed that the groups lacked homogenity in the areas of student achievement, aptitude, school and home backgrounds. An alternate suggestion that may describe the similarity between group pre-test means is that the students were studying in subject matter areas that were new to them and that the pre-tests were geared specifically to the new subject matter.

Comparisons of the mean post-test scores among groups revealed that in all subject matter areas, the control group had the highest post-test mean scores. Further analysis revealed that the differences between treatment pre- and post-test scroes ranged from 9.37 points in farm credit to 12.3 points in animal health. An analysis of variance test was conducted on the mean post-test scroes to see if these differences might be significant. In all four subject matter areas no significance was observed and the post-test scores were also assumed to be equal. Based on these findings, one could conclude that all techniques and resources had been effective in increasing the students' understanding of the subject matter being studied. Further evidence to support the above conclusion was observed when two-factor experiments using repeated measures of pre-test and post-test scores were conducted in each of the subject matter areas. In all four of the experiments, highly significant F-values were derived for treatment pre- post-test score differences. With this added evidence, it was concluded that all eight instructional approaches had been effective in increasing student achievement at each of the four grade levels.

The data were further explored to identify those differences that might exist among treatment groups after equating the data for differences in the organismic and concomitant variables. Stepwise regression analyses were conducted on all organismic and concomitant variables to identify those having the most effect on the variance among group post-test mean scores. These variables were then used as co-variates in analysis of co-variance tests in each of the subject matter areas. In three of the analysis of co-variance tests, non-significant F-values were derived. The exception was observed for the commercial fertilizer unit. In this case significance was observed. These findings suggest that the organismic and concomitant variables had little or no effect on student achievement in three of the subject matter areas. However, when adjusted subject matter post-test mean scores were computed for each treatment group using the co-variate beta values as the determiners of the extent of adjustment, changes in the treatment post-test means did occur. In all four subject matter areas, the adjusted control post-test mean was lower than the original control mean. For the animal health unit, the adjusted post-test means were higher than the original mean for the audio-tutorial, prepared lesson plan, and the single concept film groups. The remaining treatment groups had lower adjusted post-test means. The adjusted control mean was higher, however, than all other adjusted means.

In the commercial fertilizer unit, the adjusted post-test mean was higher than the original mean for the audio-tutorial, field trip, prepared lesson plan, single concept film, and video-tape groups. In this unit, the adjusted control mean was lower than all treatment means. Significance was observed in favor of the field trip, single concept film, and video-tape groups.

For the small gasoline engines unit, higher adjusted means were observed for the audio-tutorial, field trip, single concept film, and video-tape groups. The adjusted control mean for this unit was higher than three of the treatment means.

For farm credit, higher adjusted means were observed for the audio-tutorial, demonstration, overhead projected transparency, prepared lesson plans, and single concept films groups and the adjusted control mean was higher than only two of the adjusted treatment means.

While significant differences between these adjusted group means was observed for only the commercial fertizer unit, the adjusted means in each of the other three units strongly suggest that differences in organismic and concomitant variables within treatments did have an effect on the way students achieved within these groups. In addition, the consistent manner in which the post-test was adjusted for certain of the treatment groups (audio-tutorial, prepared lesson plan, and single concept film) lends strong support to hypothesizing that these techniques, when incorporated into instruction in vocational agriculture, had been more successful than the traditional method of improving student understanding of the subject matter. The fact that significance was not observed in the analysis of co-variance tests for the animal health, small gasoline engines, and farm credit units was probably due to the high number of co-variates used in each test and the low degrees of freedom with which the investigators had to work.

The findings of this study suggest many implications for agricultural educators in planning and implementing relevant and meaningful instructional programs of vocational agriculture. A few of the more important are discussed in the following paragraphs.

It was observed that all of the techniques and resources tested were effective in increasing the students' knowledge of the subject matter. Vocational agriculture instructors should make every effort to inaugurate the use of these techniques in their instructional programs. This should be done, however, after the teachers have had an opportunity to carefully study each technique and become fully aware of its potential use and limitations.

It was evident that some of the techniques were more effective in certain subject matter areas than in others. It was further observed that student aptitude, achievement, social, and home background factors were related to the successful use of these techniques measured by student achievement. These observations strongly suggest that, when using these techniques in teaching vocational agriculture, teachers should select the technique or techniques that will best present the subject matter being studied adapted to student needs and backgrounds.

While this study evaluated the use of a single technique in each of the treatment groups, in a normal instructional situation a combination of these techniques would be used to present the subject matter. Observations made from the analysis of the data in this study support a multi-media approach in presenting the subject matter. Caution should be exercised by the teacher, however, to make certain that the best techniques are selected for use and that these techniques are not over-used in the classroom. In all treatment groups, the techniques under test were used as a supplement to instructional procedures in the classroom.

The use of these instructional techniques in the teaching of vocational agriculture should be emphasized in undergraduate and graduate level teacher education programs in agriculture. At the undergraduate level, the study of these techniques should be incorporated into methods courses with emphasis placed on the development and use of each technique. Students should be encouraged to test the use of these techniques in laboratory and student teaching situations to develop an understanding of their use in real life teaching situations. At the graduate level, workshops, institutes, and short-courses should be conducted for teachers both on and off-campus to familiarize them with these techniques. Ample time should be allowed for each class session to allow those in attendance the opportunity to become familiar with the preparation, proper use, and evaluation of each technique.

The teachers' knowledge of the subject matter emerged in all four subject matter areas as a factor contributing significantly to the variance among group post-test mean scores. With the vast changes taking place in agricultural technology, keeping teachers up-to-date on these changes becomes of paramount importance. In-service education programs that provide opportunities for teachers to up-date their knowledge of animal science, agronomic science, agricultural mechanics, and agricultural economics should be greatly expanded. Participation in these programs should be encouraged at the local, district, and state level to insure teacher involvement in the program. It is evident from the findings of this study that vocational agriculture instructors can no longer rely on the knowledge they obtained as undergraduates in college to keep abreast of the changes in the technical agriculture field. They must view this achievement only as a beginning of their education and continue to study in their chosen field. This study should include a planned program of study in the technical agriculture field.

At the undergraduate level, teacher education programs should be so structured to provide a wide range of educational experiences in all fields of technical agriculture. With the high precentage of vocational agriculture programs headed by a single vocational agriculture teacher, it is imperative that they be knowledgeable in the fundamentals in all areas of technical agriculture. With the advent of more multiple teacher vocational agriculture departments, more specialization can be obtained in several areas of technical agriculture. This change will do much to provide the high quality of technical knowledge needed by vocational agriculture instructors. Caution should be exercised, however, to make certain that between the two teachers, a balanced understanding of all areas of technical agriculture is provided. Teacher education programs at the undergraduate level should be designed to provide this balance.

School systems across the country have been and are continuing to experiment with better was of providing quality education for its youth. Innovations in methodology and class scheduling are moving from the theory to the application stages. The primary purpose of these changes is that of making instruction in the classroom more relevant and meaningful to the student. Many of these changes have and will greatly affect vocational agriculture programs in local schools. The use of the instructional techniques analyzed in this experiment should contribute greatly to helping local teachers make the necessary changes in their programs to keep abreast of the changes in other areas of the secondary school curriculum. It was evident from both student and teacher evaluations of the techniques tested in their schools, that the student became more involved in the learning process and felt that they had benefited more from their instruction as a result of the use of these instructional techniques. It was further observed that in those treatment groups that encouraged independent study in addition to large group instruction, the students achieved at higher levels than did those students who were subjected to the large group instruction approach only.

As mentioned earlier, the findings of this study strongly support the recommendation that these techniques be used by local vocational agriculture instructors in their instructional programs. Before these techniques are used, however, the local instructor should thoroughly review his methodological approaches to identify were he can most effectively make use of each technique in his teaching approach. This will entail changes in approaches that in the past have been successful for the teacher. The addition of these techniques will, however, strengthen these efforts causing him to do more successful job of teaching. The use of these techniques was incorporated into the problem approach to teaching vocational agriculture. It was observed that each of these techniques could be used effectively in this approach to teaching vocational agriculture and contribute to its overall effectiveness in the classroom.

A great deal of time and effort on the part of the investigators was required to develop the techniques and resources for testing in the experiment. With the work load of the average vocational agriculture teacher, development of these techniques and resources by the local teacher for use in all subject matter areas would be extremely difficult. Priorities will need to be established by the local teacher and his available resources spent on satisfying these needs first. The establishment of a teaching resource center that would prepare materials around the

techniques tested in this study and make them available to teachers would do m ıch to satisfy this need. This need was underscored when it was observed that in all four subject matter areas, the adjusted post-test mean scores for the prepared lesson plan group had increased in value over the original post-test mean scores. In this instructional approach, all subject matter and instructional procedures were outlined for the teacher. All that was required of the teacher was to follow the lesson plan to satisfy the lesson plan objectives.

It was observed that students who had teachers who had taught vocational agriculture for a period of approximately five years had achieved at higher levels than had students whose instructors had taught for longer periods of time. This finding further clarified the need for in-service education programs for teachers to up-date their knowledge and skill in the agricultural teaching field. Included in this program should be instruction in methodology as well as technical agriculture. The implications of this finding go beyond what has been mentioned previously. Instructors who have been in a community for comparatively short periods of time bring to that community new ideas that have a refreshing influence on the people they serve. After they have been in the community awhile, their ideas become stagnant unless the teacher continually strives to improve this methods of instruction, his knowledge of the subject matter that he teaches, and his methods of working with the agricultural clientele in his community. Teachers of vocational agriculture *must* develop programs of self improvement that are designed to keep them abreast of changes in areas of technical agriculture and educational methods if their instructional programs are to be relevant and meet the real needs of those whom they serve.

As was expected, the size of class that a teacher worked with when using the techniques tested in this experiment did have an effect on student achievement. The smaller the size of class, the higher the level of student achievement tended to be, regardless of the technique being tested. It was observed, however, that certain of the techniques (overhead projected transparency, video-tape, and demonstrations) tended to work better for larger groups than others. Selection of methods by vocational agriculture teachers for classroom use should reflect these findings. Also emerging as a variable related to student achievement was that of total departmental enrollment in vocational agriculture. Students whose instructors had departments with large total enrollments achieved higher in those treatment groups (audio-tutorial, single concept film, prepared lesson plans) where the teacher could rely on the technique being tested to free time for other activities within the department.

The study was identified areas where additional research is needed to better understand the findings of this investigation.

This experiment should be replicated in other schools in other subject matter areas to see if those results would be comparable to the findings of this study. The number of schools in each treatment should be enlarged and the period of time that the experiment covers extended. More time should be spent prior to the beginning of the experiment in the development of the techniques and subject matter to be tested in the study and in training of the teachers in the proper use of these techniques. Strong consideration should be given to randomizing of students within schools thus allowing comparisons of students as well as schools.

Additional research is needed to further identify those student organismic and concomitant variables that significantly affect student achievement. How important are such factors as I.Q., aptitude, and interest to student achievement? Are home background factors and other experiences related to the subject matter under study just as or more important than such factors as I.Q., aptitude, and interest in how a student achieves?

Considerable research is needed to further assess the influence of the teacher on student achievement. In this investigation, the teacher variable contributed significantly to the differences between treatment post-test scores. If studies could be designed that would control the teacher variable more closely, a more accurate interpretation of differences due to media could be obtained.

Additional research is needed to analyze different ways that these media could be used in teaching vocational agriculture. In this investigation, only one method of using the technique was

tested in each treatment school. In addition, studies should be made to determine the effect of combining these techniques and their use in classroom instruction.

More basic research is needed is needed on how students learn. As these processes are identified, the use of media tested in this study should be adjusted to properly exploit these processes.

APPENDIX A

36

ANIMAL HEALTH

Problem Area Outlined by Days

Day	
1	The Economic Importance of Livestock Diseases and Parasites
2	Factors in Maintaining Animal Health
3 & 4	Causes, Symptoms, Prevention and Control of Major Cattle Diseases
5	Life Cycles, Symptoms, Prevention and Control of Major Cattle Parasites
6 & 7	Causes, Symptoms, Prevention and Control of Major Sheep Disease
8	Life Cycles, Symptoms, Prevention and Control of Major Sheep Parasites
9 & 10	Causes, Symptoms, Prevention and Control of Major Swine Diseases
11	Life Cycles, Symptoms, Prevention and Control of Major Swine Parasites
12	Planning a General Livestock Health Program
13	Occupational Roles of the Veterinarian, Farmer, and Other Animal Health Workers
14	Summary and Review
15	Post-Test

COMMERCIAL FERTILIZERS

Problem Area Outline by days

Day	
1	Influence of Fertilizers on Farming
2 & 3	Essential Plant Food Elements and Their Function in Plant Growth
4	Hunger Signs of Crops
5 & 6	Taking a Soil Sample
7	Liming to Correct Soil Acidity
8 & 9	Understanding the Soil Test Report
10	Determining the Amount of Nutrients Available in the Soil
11	Determining Fertilizer Application Rates
12 & 13	Selecting Fertilizer Materials to Fill Nutrient Needs
14	Summary and Review
15	Post-Test

SMALL GASOLINE ENGINES

Problem Area Outline by Days

Day	
1	Engine Principles - Two and Four-cycle Engines
2	Nomenclature - Compression Factors
3	Values
4	Valve Timing - Camshafts
5	Rings
6	Measuring Devices
7	Carburetion
8	Carburetor Types
9	Carburetor Adjustment - Governors
10	Air Cleaners
11	Ignition Systems
12	Magneto Cycle
13	Preventative Maintenance
14	Trouble Shooting - Review
15	Post-Test

FARM CREDIT

Problem Area Outline by Days

Day	
1	Introduction to Credit, "Problem"
2	"Problem", Application for Loan (Financial Statement)
3	Budgeting Principles
4	Budgeting the Problem
5	Budgeting, Complete Application for Loan
6	Types of Loans
7	Sources of Credit - Short Term & Intermediate
8	Sources of Credit - Long Term - (Land)
9	Interest Rates and Loan Costs
10	Collateral - Short and Intermediate Term
11	Collateral - Long Term
12	Credit Instruments - Short Term - Intermediate
13	Credit Instruments - Long Term - (Land)
14	Summary and Review
15	Post-Test